VOLUME 79 SEPARATE No. D-125

PROCEEDINGS

AMERICAN SOCIETY OF CIVIL ENGINEERS

JANUARY, 1953

DISCUSSION OF TORSION OF PLATE GIRDERS

(*Published in April, 1952*)

By Arthur P. Jentoft, Richard W. Mayo, and E. Russell Johnston; and F. K. Chang and Bruce G. Johnston

STRUCTURAL DIVISION

Headquarters of the Society
33 W. 39th St.
New York 18, N.Y.

PRICE $0.50 PER COPY

GUIDEPOST FOR TECHNICAL READERS

"Proceedings-Separates" of value or significance to readers in various fields are here listed, for convenience, in terms of the Society's Technical Divisions. Where there seems to be an overlapping of interest between Divisions, the same Separate number may appear under more than one item.

Technical Division	*Proceedings-Separate Number*
Air Transport	108, 121, 130, 148, 163 (Discussion: D-23, D-43, D-75, D-93, D-101, D-102, D-103, D-108)
City Planning	58, 60, 62, 64, 93, 94, 99, 101, 104, 105, 115, 131, 138, 148, 151, 152, 154, 164, 167 (Discussion: D-65, D-86, D-93, D-99, D-101, D-105, D-108, D-115, D-117)
Construction	130, 132, 133, 136, 137, 145, 147, 148, 149, 150, 152, 153, 154, 155, 159, 160, 161, 162, 164, 165, 166, 167, 168 (Discussion: D-3, D-8, D-17, D-23, D-36, D-40, D-71, D-75, D-92, D-101, D-102, D-109, D-113, D-115)
Engineering Mechanics	142, 143, 144, 145, 157, 158, 160, 161, 162 (Discussion: D-24, D-33, D-34, D-49, D-54, D-61, D-96, D-100, D-122, D-125)
Highway	138, 144, 147, 148, 150, 152, 155, 163, 164, 166, 168 (Discussion: D-XXVIII, D-23, D-60, D-75, D-101, D-103, D-105, D-108, D-109, D-113, D-115, D-117)
Hydraulics	107, 110, 111, 112, 113, 116, 120, 123, 130, 134, 135, 139, 141, 143, 146, 153, 154, 159, 164 (Discussion: D-90, D-91, D-92, D-96, D-102, D-113, D-115, D-122)
Irrigation and Drainage	129, 130, 133, 134, 135, 138, 139, 140, 141, 142, 143, 146, 148, 153, 154, 156, 159, 160, 161, 162, 164 (Discussion: D-97, D-98, D-99, D-102, D-109, D-117)
Power	120, 129, 130, 133, 134, 135, 139, 141, 142, 143, 146, 148, 153, 154, 159, 160, 161, 162, 164 (Discussion: D-96, D-102, D-109, D-112, D-117)
Sanitary Engineering	55, 56, 87, 91, 96, 106, 111, 118, 130, 133, 134, 135, 139, 141, 149, 153, 166, 167 (Discussion: D-96, D-97, D-99, D-102, D-112, D-117)
Soil Mechanics and Foundations	43, 44, 48, 94, 102, 103, 106, 108, 109, 115, 130, 152, 155, 157, 166 (Discussion: D-86, D-103, D-108, D-109, D-115)
Structural	133, 136, 137, 142, 144, 145, 146, 147, 150, 155, 157, 158, 160, 161, 162, 163, 164, 165, 166, 168 (Discussion: D-51, D-53, D-54, D-59, D-61, D-66, D-72, D-77, D-100, D-101, D-103, D-109, D-125)
Surveying and Mapping	50, 52, 55, 60, 63, 65, 68, 121, 138, 151, 152 (Discussion: D-60, D-65)
Waterways	120, 123, 130, 135, 148, 154, 159, 165, 166, 167 (Discussion: D-8, D-9, D-19, D-27, D-28, D-56, D-70, D-71, D-78, D-79, D-80, D-112, D-113, D-115)

A constant effort is made to supply technical material to Society members, over the entire range of possible interest. Insofar as your specialty may be covered inadequately in the foregoing list, this fact is a gage of the need for your help toward improvement. Those who are planning papers for submission to "Proceedings-Separates" will expedite Division and Committee action measurably by first studying the ASCE "Guide for Development of Proceedings-Separates" as to style, content, and format. For a copy of this Manual, address the Manager, Technical Publications, ASCE, 33 W. 39th Street, New York 18, N. Y.

Published at Prince and Lemon Streets, Lancaster, Pa., by the American Society of Civil Engineers. Editorial and General Offices at 33 West Thirty-ninth Street, New York 18, N. Y. Reprints from this publication may be made on condition that the full title of paper, name of author, page reference, and date of publication by the Society are given.

DISCUSSION

ARTHUR P. JENTOFT,[20] RICHARD W. MAYO,[21] AND E. RUSSELL JOHNSTON, JR.,[22] JUNIOR MEMBERS, ASCE.—The design procedure proposed by Messrs. Chang and Johnston has for the first time made available a reliable practical approach to the determination of the torsional properties of built-up sections. Using the authors' procedure and the same machine, the torsional properties of two built-up riveted column sections were investigated. The results of this investigation are included in this paper.

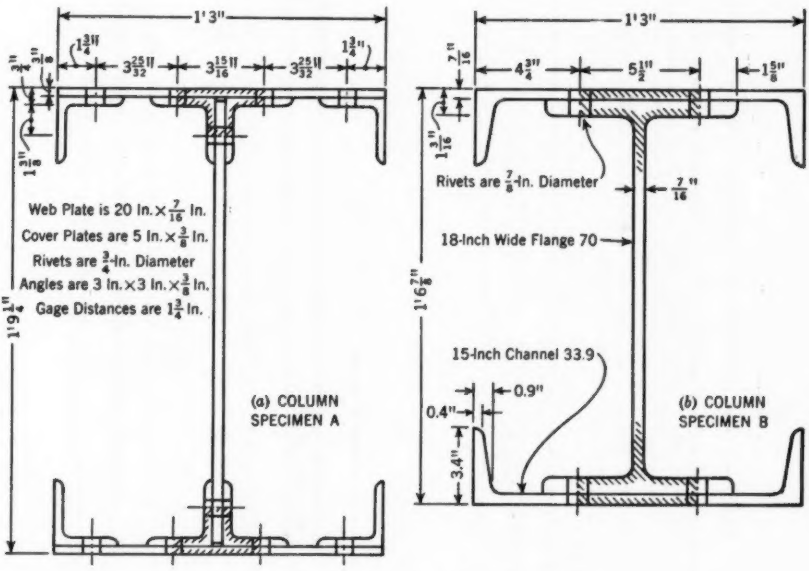


FIG. 24.—CROSS SECTIONS OF TEST SPECIMENS

Fig. 24 shows cross sections of the columns. One section was built up entirely of plates and angles, and will be designated here as Column Specimen A. The other section was composed of a wide-flange beam with channels covering the flanges, and will be referred to as Column Specimen B.

The investigation included the calculation of the stiffness, critical stresses, and strength of each of the built-up sections following the procedure suggested by Messrs. Chang and Johnston, and the testing of the 2 columns to determine

NOTE.—This paper by F. K. Chang and Bruce G. Johnston was published in April, 1952, as *Proceedings-Separate No. 125*. The numbering of footnotes, illustrations, tables, and equations in this Separate is a continuation of the consecutive numbering used in the original paper.

[20] Structural Designer, Jackson & Moreland Engrs., Boston, Mass.

[21] Structural Designer, David Taylor Model Basin, Washington, D. C.

[22] Asst. Prof. of Civ. Eng., Lehigh Univ., Bethlehem, Pa.

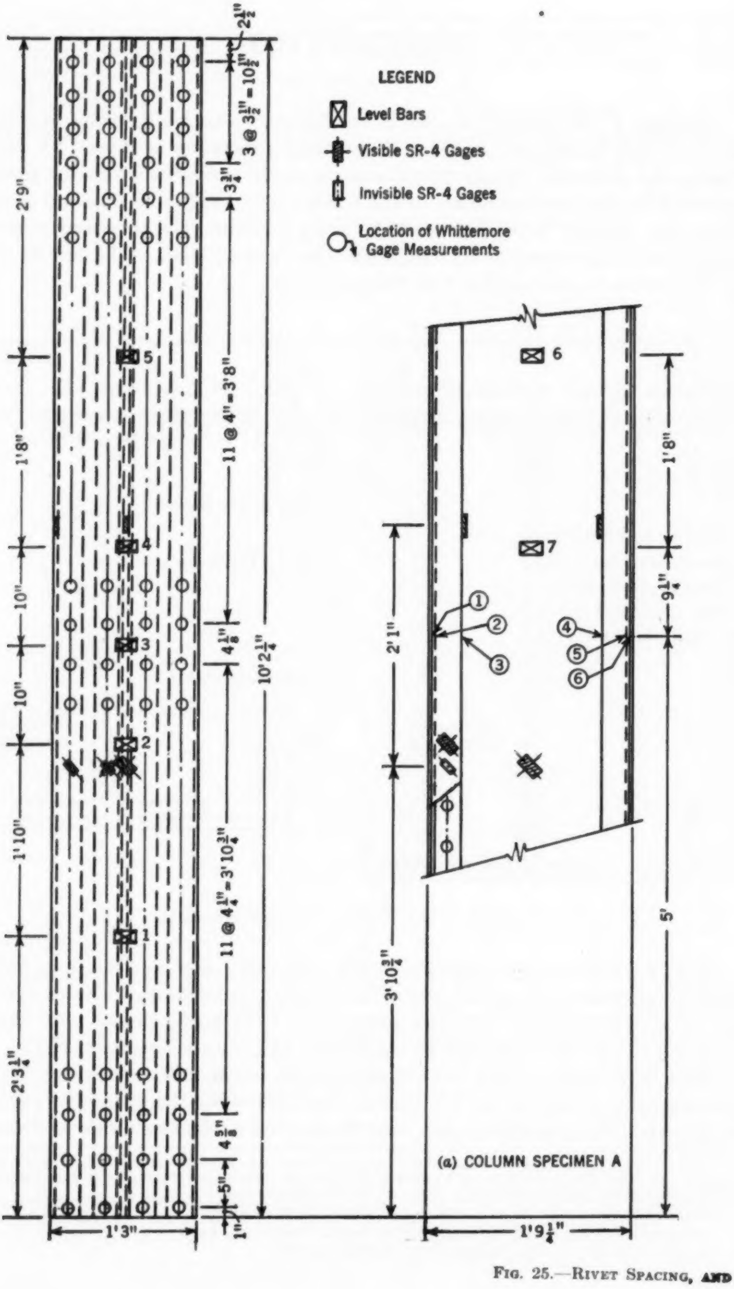
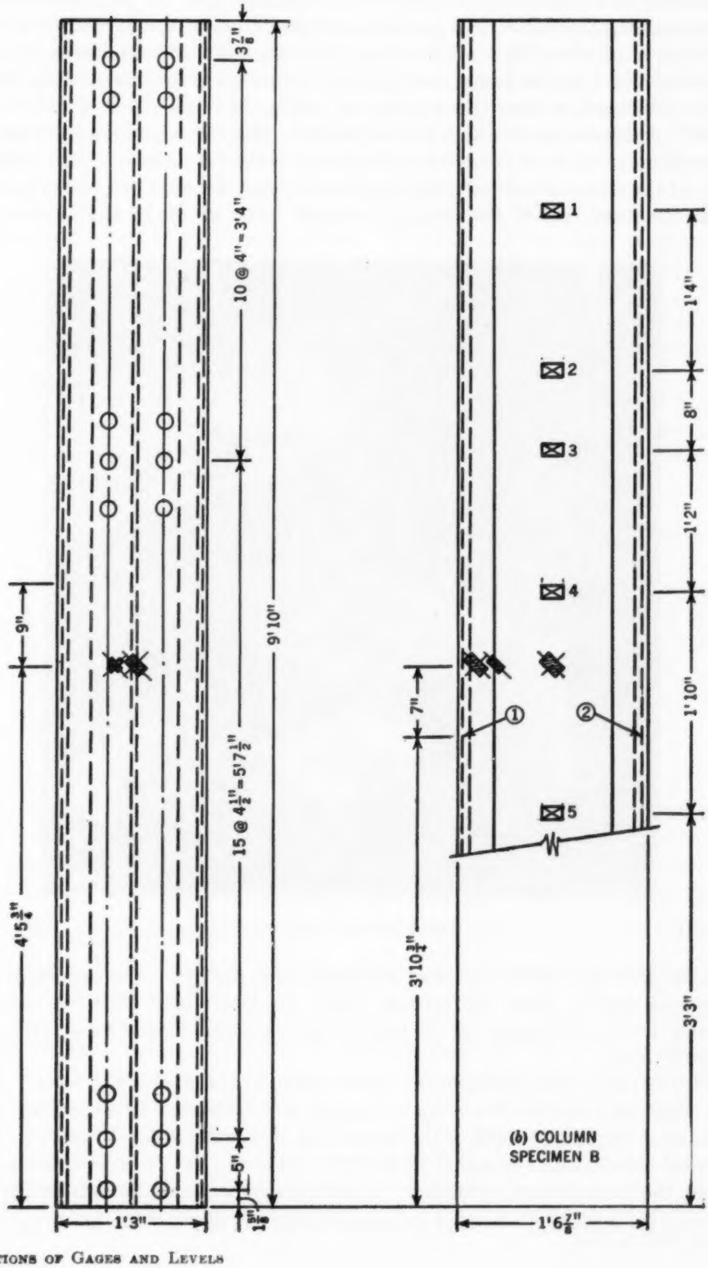


FIG. 25.—RIVET SPACING, AND



LOCATIONS OF GAGES AND LEVELS

how closely the experimental data would approximate the predicted results. In determining the theoretical properties of the columns, the assumptions were made—as implied by Mr. de Vries[4]—(*a*) that the cross-sectional area between the inside rivets on the flange and between the rivets in the web and the flange forms an integral section (shown shaded in Fig. 24), and (*b*) that other components of the section act as separate pieces. The columns were subjected to approximately uniform torsion; and measurements were made of the angle of twist, of the strain at critical points, of the slippage between the plates and adjacent members, and of the applied moment. Fig. 25 shows that each of the

FIG. 26.—TEST APPARATUS

built-up sections tested had two different rivet pitches. Because each rivet pitch was greater than the critical value, as determined from the authors' method, it was necessary to calculate and check the torque twist properties for each pitch.

Fig. 26 shows the arrangement of the instruments used in the tests. Level bars were attached to the column flanges and were used in measuring twist. Because of the short length of the specimens, it was necessary to place a few of the level bars within the zone of transition between the two rivet spacings and within the zone of end restraint. Level bars 20 in. long (shown in Fig. 26)

[4] "Strength of Beams as Determined by Lateral Buckling," by Karl de Vries, *Transactions*, ASCE, Vol. 112, 1947, p. 1245.

were used in the elastic range, and 3-in. bars were used in the post-elastic range. The locations of the level bars are shown in Fig. 25. A level bar was placed at each change of the rivet spacing in an attempt to determine the transitional effect from one section to the next. In one case, a pair of check-level bars was placed on the web. However, these extra bars were found unnecessary.

The measurement of stress distribution by SR-4 strain gages (located as shown in Fig. 25) was made at only one cross section of each beam. Measurements of plate slippage were made with a Whittemore gage at the one section indicated in Fig. 25. The shearing stress distribution in the elastic range was of primary interest in this investigation. Therefore, all the gages were applied at 45° to the longitudinal axis of the beam. Some longitudinal gages remaining from the previous column tests on these specimens were still in sufficiently good condition to provide qualitative information. A strain-coat of whitewash was applied prior to the testing, for the purpose of determining the location and direction of strain lines, and the load at which they would occur.

The first step in the procedure of the tests was to apply a third of the calculated moment of initial yield and then release this load. The column was then reloaded with approximately two thirds of this moment and again released. Finally, the loading was continued past the value of the moment causing initial yield into the plastic range.

Calculation of Torsional Properties.—The procedure followed in determining the torsional properties was essentially that used by the authors. Col. 2 of Table 5 shows that the rivet pitches of these sections were found to be critical in all cases; hence, K_{eff}-values were required. Although the corrections for hump effect and end resistant were included in the evaluation of the stiffnesses of the columns, it is agreed that these terms are in most cases negligible, and in fact will partly cancel each other. The stiffness values determined in Table 6 come from the expression,

$$K = \Sigma \tfrac{1}{3} b\, t^3 - \Sigma V t^4 + \Sigma \alpha D^4 \qquad (34)$$

in which K is the stiffness or torsion constant, b is the developed length (see Fig. 7), t is the thickness of each component of the section, V is 0.105 for each free end, and D is the diameter of the largest circle that can be inscribed in a connection of two rectangles. The value of α is given by the expression, $\alpha = 0.094 + 0.07 \frac{r}{T_F}$, in which r is the radius of the fillet and T_F is the thickness of the flange.[23] For column Specimen A, D may be computed by the expression: $D(2\, r + T_F) = (T_F + r^2) + (r + T_{w/4})$.

Values of constants for the computations of Tables 5 and 6 may be found by use of Figs. 7(a) and 24. Col. 3, Table 5, indicates the proper choice of Eqs. 17. The values in Col. 5, Table 6 are determined from Col. 4, Table 5, and K_o is the stiffness of the part of the cross section outside the integral area.

To obtain the allowable flange and web-shear stresses, p_r is determined from Eqs. 30 and 31 for an allowed shear stress of 12 kips per sq in. and an R_w-value of 9.02 kips per sq in. Thus p_r (flange) equals 4.01 in. and p_r (web) equals

[23] "Structural Beams in Torsion," by Inge Lyse and B. G. Johnston, *Transactions*, ASCE, Vol. 101, 1936, p. 862.

1.605 in. for Column Specimen A. For Column Specimen B, p_r is 2.51 in. Because the web pitch of Column Specimen A deviates further from optimum requirements than does the flange pitch, it is used in finding the web shear which in turn determines the maximum allowable torsional moment, M.

TABLE 5.—COMPUTATION OF K FOR THE INTEGRAL SECTION[a]

Actual pitch, P, in inches (1)	$p' = A + T_F$, in inches (2)	$p - p'$, in inches (3)	K_I, in inches^4 (4)	K_S, in inches^4 (5)	K_{SE}, in inches^4 (6)	K_{eff}, in inches^4 (7)
COLUMN SPECIMEN A						
4.00 (Flange)	2.00 $< p$	2.00 $> 0.4b$	1.108	0.238	0.604	0.782
4.00 (Web)	2.44 $< p$	1.56 $< 0.4b$[b]	1.530	0.173	0.86	1.170
4.25 (Flange)	2.00 $< p$	2.25 $> 0.4b$	1.108	0.238	0.568	0.738
4.25 (Web)	2.44 $< p$	1.81 $> 0.4b$[b]	1.530	0.173	0.764	1.071
COLUMN SPECIMEN B						
4.00	2.588 $< p$	1.41 $< 0.4b$	5.60	1.790	4.39	5.10
4.50	2.588 $< p$	1.91 $< 0.4b$	5.60	1.790	3.95	4.75

[a] Shaded area in Fig. 1. [b] Value of b assumed to be the same as for the flange.

In the part of Specimen A having 4-in. pitch, $\tau_{max} = \frac{1.605}{4} 12 = 4.81$ kips per sq in., and Eq. 24*b* yields $M = \frac{1.953\ (4.81)}{0.437} = 21.50$ kip-in. In the part having 4.25-in. pitch, $\tau_{max} = 4.53$ kips per sq in. and $M = 20.25$ kip-in.

TABLE 6.—COMPUTATION OF K FOR THE AREA OUTSIDE THE INTEGRAL SECTION

Description (1)	α (2)	Diameter, D, in inches (3)	Stiffness,[a] K, in inches^4 (4)	ΣK_I, in inches^4 (5)	$K_o = K - \Sigma K_I$, in inches^4 (6)
Column Specimen A:					
Flange angles	0.152	0.56	0.465		
Web and cover plates	0.123	1.346	3.936		
Total			4.401	2.638	1.76
Column Specimen B[b]	0.124	1.39	9.44	5.60	3.84

[a] Computed using Eq. 34. [b] Hump and end effects for the channel are negligible.

In the part of Specimen B having 4-in. pitch, $\tau_{max} = 7.53$ kips per sq in. and Eq. 24*c* yields $M = 58.30$ kip-in. In the part having 4.50-in. pitch, $\tau_{max} = 6.69$ kips per sq in. and $M = 50.79$ kip-in.

Test Results.—Fig. 27 shows Specimen A after testing. The brackets shown are those used with the 3-in. level bars. In general, the test results confirmed

the predicted properties of the two built-up sections as determined by the calculations. However, in some respects certain results are not completely explained by the theoretical analysis.

TABLE 7.—COMPUTATION OF K_{eff}—VALUES FOR ENTIRE SECTION

Description	Column Specimen A		Column Specimen B	
	Pitch = 4.00 in.	Pitch = 4.25 in.	Pitch = 4.00 in.	Pitch = 4.50 in.
K_e[a]	1.76	1.76	3.84	3.84
K_{eff} of Int. Area[b]	1.95	1.81	5.10	4.75
Total K_{eff}	3.71	3.57	8.94	8.59

[a] From Table 6. [b] From Table 5.

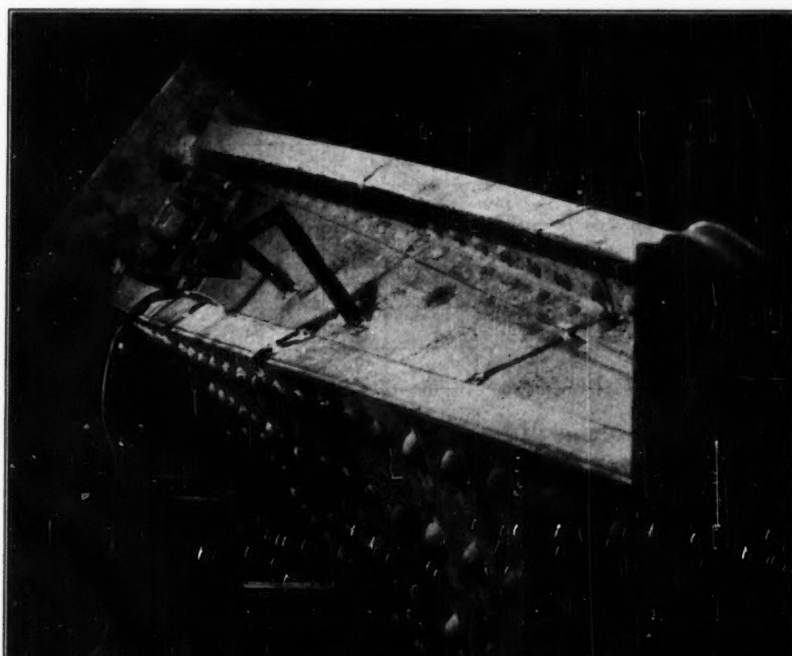


FIG. 27.—COLUMN SPECIMEN A AFTER TESTING

The first column tested was built up entirely of plates and angles. The torsional rigidity constant K was determined analytically for each of the 2 rivet pitches of this column. The values of K_{eff} were 3.57 in.[4] and 3.71 in.[4] for the 4.25-in. and the 4-in. rivet pitches, respectively. Curves in Figs. 28

and 29, relating plotted angle of twist to moment for this beam, show that the calculated K constants were very close to the actual conditions up to the point of initial yield. The legend for Fig. 28 is the same as that for Fig. 27. However, in the plastic range, where the K-value would be expected to decrease, the curves show an increase in stiffness of the member. This increase of stiffness continued until the web of the beam began to buckle. The high stiffness during the plastic range for this flexible column may have been caused partly by the moment produced by the increase in longitudinal forces as the twisting moment increased. It can be seen from Figs. 28 and 29 that the effect of the two rivet pitches is not great and that the K constant is nearly the same for all portions of the beam.

The second beam tested was composed of a wide-flange beam and 2 channels acting as cover plates. The constants K_{eff} calculated for this beam were 8.59

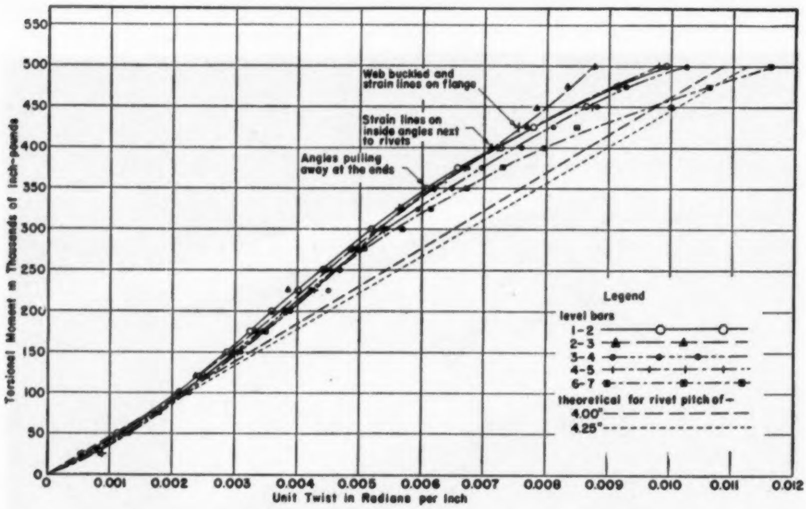


FIG. 28.—TORQUE-TWIST RELATIONSHIPS FOR COLUMN SPECIMEN A

in.^{4} and 8.94 in.^{4} for the 4.50-in. and 4-in. rivet pitches, respectively. From the curves of Fig. 30 it can be seen that these values were very close to actual conditions up to the initial yield, after which the actual stiffness decreased slowly for the remainder of the test. In the plastic range this beam behaved more as expected than did the previous beam. However, this beam was of thicker material and was not as flexible.

Fig. 31 shows how the actual K-values varied with respect to moment throughout the test for each of the beams. The plotted points in Fig. 10 are average stiffnesses for the 2 sections. For Specimen B there was a gradual decrease in K as the moment increased. The results for the other specimen indicated an increase in K until the web began to buckle, after which this K-value decreased also.

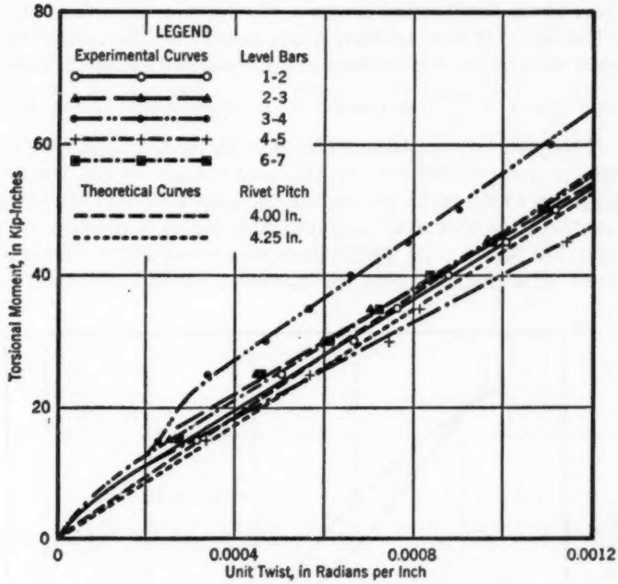


FIG. 29.—TORQUE-TWIST RELATIONSHIPS FOR COLUMN SPECIMEN A IN PART OF THE ELASTIC RANGE

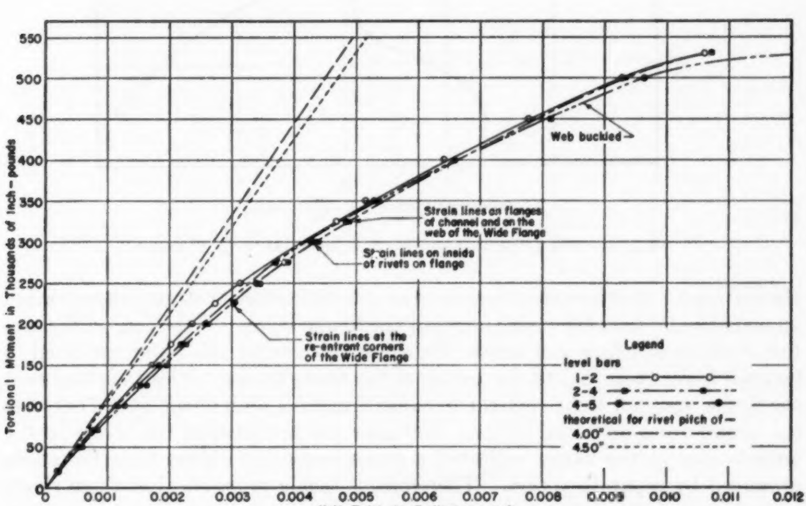


FIG. 30.—TORQUE-TWIST RELATIONSHIPS FOR COLUMN SPECIMEN B

The shear stress distribution across a cross section of each of the beams is plotted in Fig. 32. On both sections it was found that the values of the actual shear stresses were quite close to those of the theoretical shear stresses as found from the equation $\tau = \frac{M t}{K}$, in which t is the thickness of the material acting integrally at the point in question. The shear stress distributions were plotted at a torsional moment of 20 kip-in. for the column made up of plates and angles, and at a torque of 40 kip-in. for the section made up of a beam and two channels. These moment-values were near that of initial yield in both cases. The shearing stresses in Fig. 32 are quite high in parts that were assumed to act integrally, and the stress for a given K-value varies almost directly with the thickness of

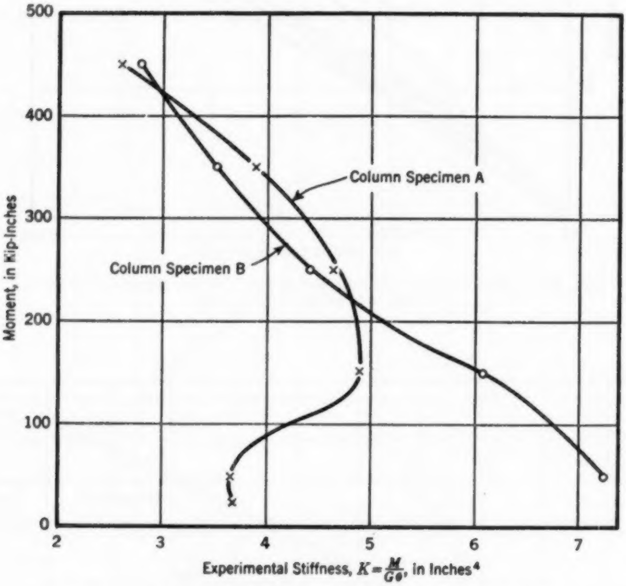


Fig. 31.—Variation of Experimental Stiffness with Torque

the material. On the wide-flange section, the highest shear stress concentration appeared to be near the inside edges of the flange holes. However, on the section built up of plates and angles, the shearing stress at this point appeared to be even lower than that at the center of the beam flange. This indicates that the rivets were not tight enought to cause integral action of the plates between the center rows of flange rivets. The gage placed between the rivets in the outside row on the flange indicated a stress somewhat higher than the stress produced by separate action. Therefore, it seems probable that these rivets caused enough friction between the plates to result in somewhat better than separate action of the outside portions of these plates. More gages would be needed as checks to make the shear stresses at these points more reliable. In

general, the experimental shear stresses of both beams agreed fairly closely with the calculated shear stresses based on the usual assumptions.

In Fig. 33, the longitudinal stress distribution was plotted for moments of 250 kip-in. and 500 kip-in for Specimen B and Specimen A, respectively. In

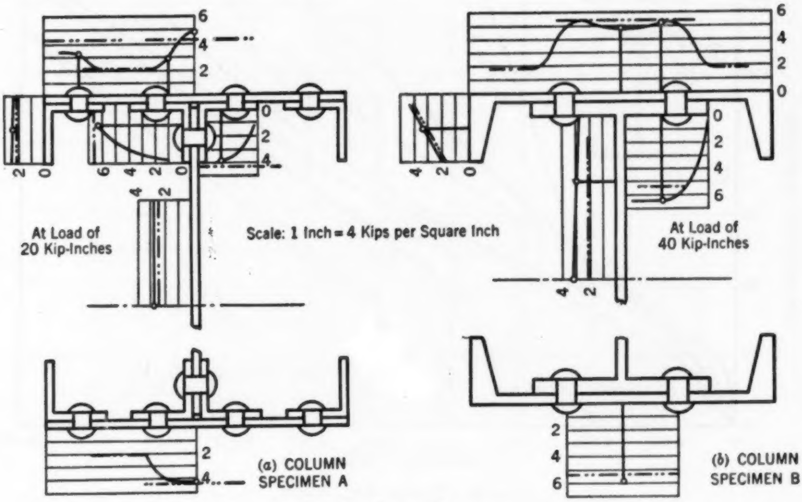


Fig. 32.—Shear Stresses

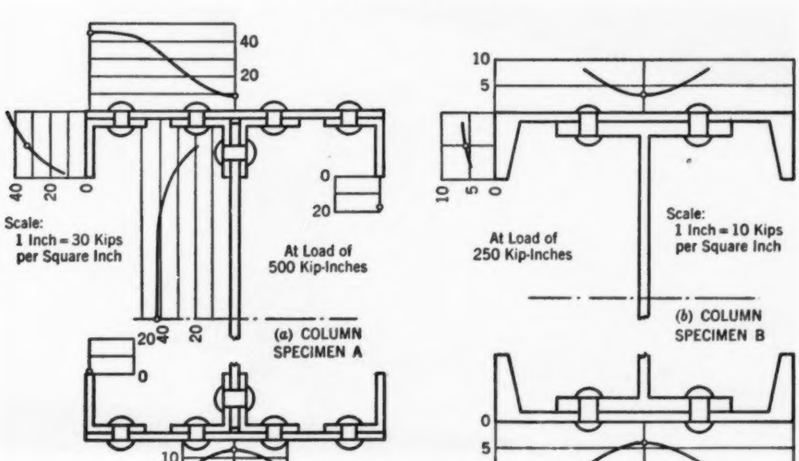


Fig. 33.—Longitudinal Stresses

both tests, insufficient longitudinal gages were applied to give representative longitudinal stress distributions, and the effect was that of having only local longitudinal stresses determined accurately.

No calculations were made for the amount of slip that could be expected to occur between various components of either of the beams during the torsion test. However, most of the curves plotted in Fig. 34 for slip of adjacent mem-

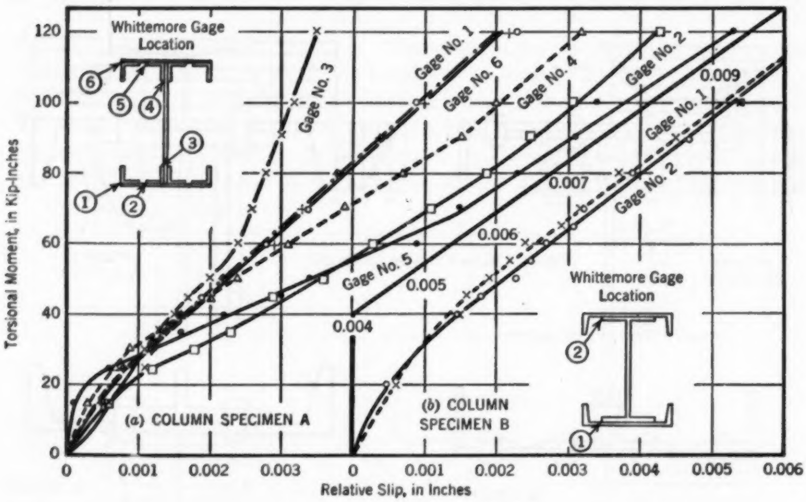


Fig. 34.—Torque-Slip Curves

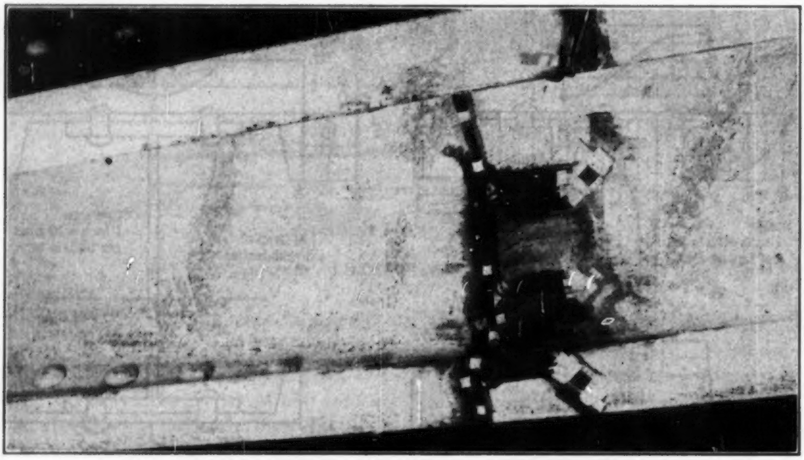


Fig. 35.—Column Specimen B After Testing

bers with respect to moment were reasonable, and in most cases the amount of slip increased more rapidly as larger moments were applied.

Fig. 29, shown previously, is a general view of Column Specimen A after testing. The strain lines caused by buckling may be seen along the web of the

member. These occurred at intervals of approximately the width of the web plate.

The strain lines due to buckling in Column Specimen B may be seen in Fig. 35. The strain line pattern near a re-entrant corner of the wide-flange beam in

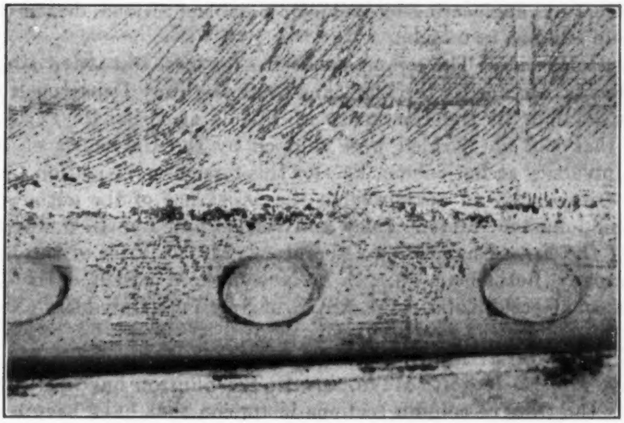


FIG. 36.—STRAIN LINE PATTERN, FILLET OF WIDE-FLANGE BEAM

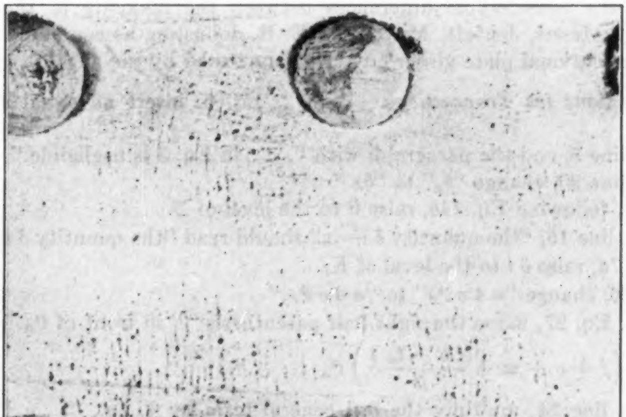


FIG. 37.—STRAIN LINE PATTERN ON CHANNEL

this column is pictured in Fig. 36. The fillet runs horizontally across the middle of the view. Fig. 37 shows the strain line pattern on the channel that forms the cover plate of Specimen B.

Conclusions.—The various assumptions proposed by the authors to make possible the determination of the properties of built-up riveted girders apply

satisfactorily to columns of somewhat different cross section than the girders used in the authors' tests. Considering the very large difference between the properties of such sections when acting entirely integrally and when acting separately, it is believed that the authors' assumptions give remarkably good results. This paper undoubtedly makes an important contribution to the field of structural engineering by making available a rational design procedure for built-up sections in torsion.

Acknowledgments.—The column specimens for these tests were designed and constructed as columns for the Louisiana State Highway Department and were tested as columns at the University of Illinois at Urbana. Parts of these columns that had not yielded were shipped by the University of Illinois to Lehigh University at Bethlehem, Pa., for this torsion investigation.

The writers wish to acknowledge the assistance of the authors, Messrs. Chang and Johnston, Messrs. Eney and Harpel and Lyman S. Beedle, A.M. ASCE, of the Fritz Engineering Laboratory; Mr. de Vries of the Bethlehem Steel Company (Bethlehem, Pa.); N. M. Newmark, M. ASCE, of the University of Illinois; and Gerald Kubo, A. M. ASCE, of New York University (New York).

F. K. CHANG,[24] J. M. ASCE, AND BRUCE G. JOHNSTON,[25] M. ASCE.—Evidently, Messrs. Jentoft, Mayo, and E. R. Johnston have performed with great care the tests of column sections in torsion that have been reported in their discussion. Their contribution and corroboration are greatly appreciated by the authors of this paper. This corroboration is especially gratifying in view of the considerable differences between the make-up of the sections tested by Messrs. Jentoft, Mayo, and E. R. Johnston, as compared with the more conventional plate girder cross sections tested by the authors.

Corrections for Transactions.—Page 2, Eq. 5, insert an equal sign after τ_{max}.

Page 3, line 5, end the paragraph with ". . . in Eq. 3 is negligible."

Page 4, line 20, change "θ_x" to "θx."

In line 2, following Eq. 14*b*, raise t^3 to the level of Σ.

Page 11, line 16, "the quantity $\delta\, l$—is" should read "the quantity $\delta\, l$; $\delta\, l$."

In Eq. 17*a*, raise $\delta\, l$ to the level of K_I.

In Eq. 26, change "$n\, 4\, e\, t^3{}_F$" to "$n\, 4\, c\, t^3{}_F$."

Page 15, Eq. 27, move the right half parenthesis")" in front of $t^3{}_A$. i.e., ". . .

$$+ 4 \left(f + e + m + \frac{(b - t_w)}{2}\right) t^3{}_A \; . \; . \; . \; .\text{''}$$

Page 20, line 24, multiply the 3rd general term by $\frac{1}{3}$. i.e., ". . . $\frac{1}{3} \times 2 \times 4 \times 2 \times 0.625^3$."

Page 21, line 22, change "5.5" below the horizontal line to "6.5" and change "43.10" after the equal sign to "45.16."

Page 21, line 4, change dimension a from "45.75" to "47.25."

Page 21, line 25, change "40%" to "35%."

Page 21, lines 31 and 34, change "*W*" to "*S*."

---

[24] Junior Bridge Designer, Pennsylvania State Highway Dept., Harrisburg, Pa.
[25] Prof., Structural Eng., Univ. of Michigan, Ann Arbor, Mich.

Page 22, in Col. 5, opposite line P-1-7, change "20" to "170." Then correct order to put P-1-6 and P-1-7 in sequence by interchanging completely these two lines.
In the caption of Table 1(*h*), change "50-In." to "20-In."
In Col. 5, the last line of Table 1, change the leaders to "(P)."
Page 23, in Col. 1, Table 1(*i*), change "T-1B-1" to "T-6B-1."
Page 26, line 6, change "8.50" below the horizontal line to "8.56," and change "9.21" after the equal sign to "9.16."

CURRENT PAPERS AND DISCUSSIONS

Proceedings-Separate Number	Date Available	Title and Author	Discussion closes
137	Aug., 1952	"Construction of the Delaware Memorial Bridge," by Homer R. Seely	Jan. 1
138	Aug., 1952	"The Value and Administration of a Zoning Plan," by Huber Earl Smutz	Jan. 1
139	Aug., 1952	"Nonlinear Electrical Analogy for Pipe Networks," by Malcolm S. McIlroy	Jan. 1
140	Aug., 1952	"Irrigation Water Rights in the Humid Areas," by Howard T. Critchlow	Jan. 1
141	Aug., 1952	"Effect of Entrance Conditions on Diffuser Flow," by J. M. Robertson and Donald Ross	Jan. 1
142	Sept., 1952	"Unconfined Ground-Water Flow to Multiple Wells," by Vaughn E. Hansen	Feb. 1
143	Sept., 1952	"Hydrodynamic Problems in Three Dimensions," by P. G. Hubbard and S. C. Ling	Feb. 1
144A 144B	Sept., 1952	"Aerodynamic Stability of Suspension Bridges," Progress Report of the Advisory Board on the Investigation of Suspension Bridges	Feb. 1
145	Sept., 1952	"Torsion of I-Type and H-Type Beams," by John E. Goldberg	Feb. 1
146	Sept., 1952	"Electrical Analogies and Electronic Computers: Surge and Water Hammer Problems," by Henry M. Paynter	Feb. 1
147	Sept., 1952	"The Delaware Memorial Bridge: Design Problems," by Charles H. Clarahan, Jr., and Elmer K. Timby	Feb. 1
148	Oct., 1952	"Bank Stabilization by Revetments and Dikes," by Raymond H. Haas and Harvill E. Weller	Mar. 1
149	Oct., 1952	"Industrial Waste Treatment in Iowa," by Paul Bolton	Mar. 1
150	Oct., 1952	"East St. Louis Veterans Memorial Bridge," by A. L. R. Sanders	Mar. 1
151	Oct., 1952	"Topographic Mapping in Kentucky," by Phil M. Miles	Mar. 1
152	Oct., 1952	"Methods for Making Highway Soil Surveys," by K. B. Woods	Mar. 1
153	Oct., 1952	"Characteristics of Fixed-Dispersion Cone Valves," by Rex A. Elder and Gale B. Dougherty	Mar. 1
154	Nov., 1952	"A Navigation Channel to Victoria, Tex.," by Albert B. Davis, Jr.	Apr. 1
155	Nov., 1952	"Field Study of a Sheet-Pile Bulkhead," by C. Martin Duke	Apr. 1
156	Nov., 1952	"Rice Irrigation in Louisiana," by E. E. Shutts	Apr. 1
157	Dec., 1952	"Radial Impact on an Elastically Supported Ring," by Edward Wenk, Jr.	May 1
158	Dec., 1952	"Flexure of Double Cantilever Beams," by F. E. Wolosewick	May 1
159	Jan., 1953	"Development of a Flood-Control Plan for Houston, Tex.," by Ellsworth I. Davis	June 1
160	Jan., 1953	"Ice Pressure Against Dams: Studies of the Effects of Temperature Variations," by Bertil Löfquist	June 1
161	Jan., 1953	"Ice Pressure Against Dams: Some Investigations in Canada," by A. D. Hogg	June 1
162	Jan., 1953	"Ice Pressure Against Dams: Experimental Investigations by the Bureau of Reclamation," by G. E. Monfore	June 1
163	Jan., 1953	"A Comparison of Design Methods for Airfield Pavements," Progress Report of the Committee on Correlation of Runway Design Procedures of the Air Transport Division	June 1
164	Feb., 1953	"Water Supply Engineering," Report of Committee on Water Supply Engineering of the Sanitary Engineering Division for the Period Ending September 30, 1951	July 1
165	Feb., 1953	"Design Curves for Anchored Steel Sheet Piling," by Walter C. Boyer and Henry M. Lummis, III	July 1
166	Feb., 1953	"The Design of Flexible Bulkheads," by James R. Ayers and R. C. Stokes	July 1
167	Feb., 1953	"Sewage Disposal in Tidal Estuaries," by Alexander N. Diachishin, Seth G. Hess, and William T. Ingram	July 1
168	Feb., 1953	"Special Design Features of the Yorktown Bridge," Maurice N. Quade	July 1

AMERICAN SOCIETY OF CIVIL ENGINEERS

OFFICERS FOR 1953

PRESIDENT

WALTER LEROY HUBER

VICE-PRESIDENTS

Term expires October, 1953:

GEORGE W. BURPEE
A M RAWN

Term expires October, 1954:

EDMUND FRIEDMAN
G. BROOKS EARNEST

DIRECTORS

Term expires January, 1953:

OTTO HOLDEN
FRANK L. WEAVER
GORDON H. BUTLER
GEORGE W. LAMB
EDWARD C. DOHM

Term expires October, 1953:

KIRBY SMITH
FRANCIS S. FRIEL
WALLACE L. CHADWICK
NORMAN R. MOORE
BURTON G. DWYRE
LOUIS R. HOWSON

Term expires October, 1954:

WALTER D. BINGER
FRANK A. MARSTON
GEORGE W. McALPIN
JAMES A. HIGGS
I. C. STEELE
WARREN W. PARKS

Term expires October, 1955:

CHARLES B. MOLINEAUX
MERCEL J. SHELTON
A. A. K. BOOTH
CARL G. PAULSEN
LLOYD D. KNAPP
GLENN W. HOLCOMB
FRANCIS M. DAWSON

PAST-PRESIDENTS

Members of the Board

GAIL A. HATHAWAY
CARLTON S. PROCTOR

TREASURER

CHARLES E. TROUT

EXECUTIVE SECRETARY

WILLIAM N. CAREY

ASSISTANT TREASURER

GEORGE W. BURPEE

ASSISTANT SECRETARY

E. L. CHANDLER

PROCEEDINGS OF THE SOCIETY

HAROLD T. LARSEN
Manager of Technical Publications

DEFOREST A. MATTESON, JR.
Assoc. Editor of Technical Publications

PAUL A. PARISI
Asst. Editor of Technical Publications

COMMITTEE ON PUBLICATIONS

LOUIS R. HOWSON

FRANCIS S. FRIEL
I. C. STEELE
GLENN W. HOLCOMB
FRANK A. MARSTON
NORMAN R. MOORE